Soil Science Australia Fundamentals Exam

Performance Objectives

Soil Science Australia's

Australian Exam and Procedures Committee

Effective October 1, 2017

SOIL SCIENCE FUNDAMENTAL PERFORMANCE OBJECTIVES

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FOREWORD

This booklet lays out the Performance Objectives (POs) for the *Soil Science Fundamentals Examination*. The POs are intended to help prospective soil science professionals to prepare for the *Fundamentals Exam*, which was developed by *Soil Science Australia* (SSA) in collaboration with the *Soil Science Society of America* (SSSA). *Soil Science Australia* considers the POs to be the minimum professional competencies required by soil scientists working on environmental and agricultural problems in Australia.

The POs were developed by the *Australian Examinations and Procedures Committee* (AEPC) under the auspices of SSA's Accreditation Board for the Certified Professional Soil Scientist, CPSS. The AEPC sought advice from practicing soil consultants, State government agencies and academics across Australia. The *Soil Science Fundamentals Examination* is the product of a balanced application of the POs and can best be studied for by developing a technical understanding of each PO.

The AEPC reviews and revises the POs regularly with input from end users to ensure the most pertinent soils knowledge is tested. However, new discoveries and approaches in Soil Science occur continuously, so the AEPC welcomes comments and suggestions for possible modifications to the next edition of the POs. Comments should be sent to the Executive Officer, Australian Society of Soil Science Inc., PO Box 737, Prospect East, South Australia 5082..

Soil Science Australia, the CPSS Board and the AEPC thank the many volunteers who contributed to the preparation of this document, including staff in the *Soil Science Society of America*. It would not be possible without their dedication to the profession of Soil Science.

A note on conversions:

Examinees should be able to calculate quantities in any units. Conversion factors will be provided for questions within the exam.

SOIL CHEMISTRY AND MINERALOGY

Competency Area 1. Basic Concepts of Soil Chemistry

1. Define cation exchange capacity.

2. Define anion exchange capacity.

3. Define pH dependent and independent charge.

4. Describe field and laboratory methods for determining soil pH.

5. Describe how pH test method influences pH readings.

6. Convert to and from the following units:
   a. moles.
   b. grams.
   c. molecular weight.
   d. moles of charge.

7. Describe conditions that influence clay flocculation and dispersion.

8. Define the following terms in relation to the soil solution:
   a. electrical conductivity.
   b. ion activity.

9. Define and calculate base saturation given appropriate data.

Competency Area 2. Solid Phase

1. Identify the following clay mineral structures.
   a. 1:1.
   b. 2:1.

2. Describe differences in, and characteristics of, the following:
   a. kaolinite.
   b. mica (illite).
   c. smectite (montmorillonite).
   d. oxides of iron, aluminium and manganese.
   e. amorphous materials.

3. Describe and estimate cation exchange capacity based on soil organic matter content, clay content and clay mineralogy.

Competency Area 3. Mineral Weathering

1. Identify the chemical and physical processes that contribute to mineral weathering.

2. Define primary and secondary minerals.

3. Identify nutrients released from the following primary and secondary minerals:
   a. feldspar.
   b. gypsum.
   c. calcite.
   d. hematite.
   e. dolomite.
   f. pyrite.

4. Describe why CO_2 has an acidifying effect on the soil solution.

Competency Area 4. Solid/Solution Equilibria

1. Define mass flow and diffusion, and list the major soil chemical and physical properties affecting mass flow and diffusion.

2. Define the following processes that occur at the mineral/solution and/or solution/atmosphere interface that control the fate and transport of chemicals in soils:
   a. adsorption.
   b. precipitation.
   c. ion exchange.
   d. oxidation/reduction.
   e. complexation.
   f. volatilization.

Competency Area 5. Ion Exchange

1. Convert between meq per 100 g, centimoles of charge per kilogram ($cmol_c kg^{-1}$), and kilograms per ha when given a depth and a bulk density specification.

2. Calculate CEC and percent base (or other ion) saturation, given cation concentrations, mass of soil, and volume of extracting solution.

3. Explain how change in soil pH influences the cation and anion exchange capacities of soils.

4. Describe the effect of addition of cations to the soil on the composition of cations on the exchange sites.

5. Explain how pH influences CEC of 1:1 and 2:1 clay minerals and amorphous materials.

6. Explain the difference in magnitude between cation concentration in soil solution and on the soil exchange sites.

7. Recognize the relative bonding strength of aluminium, calcium, magnesium, potassium and sodium on colloids.

Competency Area 6. Sorption and Precipitation Reactions

1. Describe the relationship between soil pH and the chemical solubilities of the following ions:
   a. aluminium, iron, copper, zinc and manganese.
   b. calcium and magnesium.
   c. phosphate and molybdate.
   d. boron.

2. List factors affecting mobility in soil of the following:
   a. phosphates.
   b. sulfates.
   c. nitrates.
   d. heavy metals.
   e. organic compounds.
   f. pesticides.

3. Recognize the difference in sorption between ionic and non-ionic compounds.

Competency Area 7. Acidity

1. Differentiate between active, exchangeable, non-exchangeable, and reserve acidity.

2. Explain how soil colloids buffer soil pH changes caused by acid inputs, liming amendments and nitrogen fertilizers.

3. Identify the major factors that contribute to soil acidity.

4. Describe how soil salts influence soil pH measurements.

5. Describe buffering in soils as it relates to acid-base reactions.

6. Name the form of acidity the pH electrode measures.

Competency Area 8. Oxidation-Reduction Reactions

1. Define oxidation - reduction potential.

2. Identify conditions which lead to a soil becoming reduced.

3. Identify elements likely to be part of redox reactions in the soil.

4. Describe how the redox state of the soil influences ion solubilities.

5. Describe the role of organic matter in oxidation-reduction reactions.

6. Identify the oxidized and reduced forms of the following elements:
   a. manganese.
   b. iron.
   c. sulfur.
   d. nitrogen.
   e. carbon.

Competency 9. Alkaline and Salt Affected Soils

1. Define saline, sodic and saline/sodic soils as defined and used in Australia.

2. Compare and contrast how irrigation under arid, temperate and humid climates can influence soil salinity and sodicity.

3. Describe the unique physical and chemical characteristics of sodic, saline and saline/sodic soils.

4. Describe special management concerns of sodic, saline and saline/sodic soils.

5. Describe chemical and physical remediation techniques for sodic, saline and saline/sodic soils.

6. Define with appropriate and consistent units:
   a. sodium adsorption ratio (SAR).
   b. electrical conductivity (EC).
   c. exchangeable sodium percentage (ESP).

7. Calculate sodium adsorption ratio and exchangeable sodium percentage given appropriate data.

8. Know common soil anions in saline and/or sodic soils.

9. Know anthropogenic sources of salinity and sodicity.

10. Estimate the concentration of soluble salts (mg/l or ppm) based on electrical conductivity (EC) and understand the limitations of the estimate.

SOIL FERTILITY AND NUTRIENT MANAGEMENT

Competency Area 1. Roles of Nutrients in Plants and their Availability in Soils

1. Identify the useable ionic forms of the following essential plant nutrients and differentiate macro- and micronutrients.
    a. nitrogen.
    b. phosphorus.
    c. potassium.
    d. sulfur.
    e. calcium.
    f. iron.
    g. magnesium.
    h. manganese.
    i. copper.
    j. zinc.
    k. boron.
    l. chloride.

2. Describe the principal roles of the following essential nutrients in plant growth:
    a. nitrogen.
    b. potassium.
    c. phosphorus.
    d. magnesium.
    e. sulfur.
    f. calcium.
    g. iron.
    h. zinc.

3. Recognize visual plant deficiency symptoms of the following nutrients:
    a. nitrogen.
    b. potassium.
    c. phosphorus.
    d. iron.
    e. sulfur.
    f. magnesium.
    g. zinc

4. Recognize visual plant toxicity symptoms of the following elements:
    a. manganese.
    b. boron.
    c. aluminium.

5. Describe temperature effects on plant availability of:
    a. nitrogen.
    b. phosphorus.

6. Describe aeration effects on plant availability of:
    a. nitrogen.
    b. phosphorus.
    c. iron.

7. Describe the mechanisms of phosphorus fixation in alkaline soils and in acid soils.

8. Know how the following conditions affect the relative concentration of NH_4^+ and NO_3^-:
    a. soil moisture content.
    b. temperature.
    c. pH.
    d. soil organic matter content.
    e. redox.

9. Describe the concepts of root interception, mass flow and diffusion in the uptake of N, P, K and S.

10. Describe the effect of carbonates and pH on N volatilization for urea and ammonium fertilizers.

Competency Area 2. pH

1. Describe the effects of the following on soil pH over time:
    a. anhydrous ammonia.
    b. ammonium nitrate.
    c. ammonium sulfate.
    d. monoammonium phosphate (MAP).
    e. urea.
    f. superphosphate.

2. Explain how soil pH affects the availability of the following elements to plants:
    a. nitrogen.
    b. phosphorus.
    c. potassium.
    d. sulfur.
    e. calcium.
    f. iron.

g. magnesium.
h. manganese.
i. copper.
j. zinc.
k. molybdenum.
l. boron.
m. chloride.
n. aluminium.

Competency Area 3. Acidifying and Liming of Soils

1. Know how soil pH, CEC, organic matter and texture affect requirements for liming materials.

2. Identify soil amendments that increase or decrease soil pH.

3. Explain the process by which liming or acidifying amendments raise or lower soil pH.

4. Describe how particle size and purity affect the application rate of liming and acidifying materials.

5. Calculate the amount of liming material required to neutralize soil acidity.

6. Calculate the amount of acidifying material required to neutralize soil alkalinity.

7. Describe the differences in neutralizing value of different sources of liming or acidifying ameliorants.

Competency Area 4. Nutrient Sources

1. Compare and contrast the availability of organic and inorganic sources of nitrogen and phosphorus.

2. List examples of readily available and slow-release fertilizers.

3. Identify conditions under which readily available and slow-release fertilizers are recommended.

4. Describe the N, P, K and S cycles with respect to soil fertility.

Competency Area 5. Soil Fertility Sampling

1. Describe the importance of the following on soil testing results:
   a. time of year.

b. landscape position.
c. past land management practices.
d. depth.
e. sampling scheme/method.

2. Know the importance of composite samples and sample locations.

3. Describe different plot sampling strategies.

4. Describe soil variability and how this affects soil sampling and mapping.

5. Describe the role of temporal sampling in soil biological applications.

Competency Area 6. Soil and Plant Analyses and Interpretations

1. Know the importance of plant tissue analysis for identifying plant nutrient toxicity or deficiency symptoms.

2. Describe how the following influence soil test recommendations:
   a. build up and maintenance additions.
   b. cation balance.
   c. nutrient sufficiency.
   d. crop removal.

3. Calculate fertilizer application rates based on nutrient source and recommendation.

4. Know the purpose of soil testing for crop production.

Competency Area 7. Nutrient Management

1. Describe the water quality implications of excess application of nitrogen and phosphorus to soil.

2. Describe environmental concerns associated with manure application on soils.

3. Describe how timing of application affects the effectiveness of:
   a. nitrogen.
   b. phosphorus.
   c. liming material.
   d. acidification material.
   e. organic sources of nutrients.
   f. gypsum.

4. Describe advantages and disadvantages of applying fertilizers to soils via:
    a. broadcast with incorporation.
    b. broadcast without incorporation.
    c. banding.
    d. foliar.
    e. fertigation.
    f. injection.

5. Calculate nutrient uptake and removal given biomass quantity and nutrient concentrations.

6. Identify the information needed to assess nutrient availability from organic residues.

7. Contrast nutrient availability from the following:
    a. fertilizers.
    b. compost.
    c. manures.
    d. plant residues.
    e. cover crops.
    f. biochar.
    g. biosolids.

SOIL PHYSICS

Competency Area 1. Physical Properties

1. List the international system for soil particle size classes.

2. Determine the textural class of a soil using the equilateral soil textural triangle given the percentages of sand, silt, and clay.

3. Determine appropriate modifiers of textural classes given relevant data.

4. Identify the range of sand, silt or clay content for any given soil texture using the soil textural triangle.

5. Define and calculate soil bulk density.

6. Define and calculate soil porosity.

7. Define and calculate soil particle density.

8. Know quantitative methods for determining particle size distribution.

9. Define soil structure.

10. Describe the following types of soil structures:
    a. angular blocky.
    b. subangular blocky.
    c. granular.
    d. prismatic.
    e. platy.
    f. columnar.
    g. single-grained.
    h. polyhedral.
    i. massive.
    j. lenticular.

11. Explain how land management practices affect soil bulk density and pore space.

12. Describe how soil texture and structure influence water movement and water holding capacity.

13. Given two of the following, calculate the third: total soil volume, soil bulk density, and dry mass of the soil.

14. Describe soil conditions conducive to surface crusting.

15. Describe how soil colour indicates soil physical, chemical, and biological properties.

16. Define hydrophobicity and identify factors that affect hydrophobicity in soil.

Competency Area 2. Soil-Water Relationships

1. Describe the gravimetric method of determining soil water content.

2. Calculate gravimetric and volumetric water contents.

3. Given bulk density, convert gravimetric water content to volumetric water content and understand any assumptions.

4. Define field capacity or drained upper limit.

5. Define permanent wilting point or the crop lower limit.

6. Define plant available water in terms of field capacity/drained upper limit and permanent wilting point/crop lower limit.

7. Use the soil water retention curve to estimate plant available water.

8. Identify the following components of the hydrologic cycle:
    a. precipitation.
    b. evaporation.
    c. transpiration.
    d. runoff.
    e. infiltration.
    f. redistribution.
    g. deep drainage.
    h. storage.

9. Define:
    a. perched water table.
    b. groundwater table.
    c. vadose zone.
    d. capillary fringe.
    e. aquifer.

10. List soil properties that affect water movement through the soil.

Competency Area 3. Water Movement and Transport Processes

1. Define the following soil water potentials:

a. pressure potential.
b. matric potential.
c. gravitational potential.
d. osmotic potential.
e. total potential.

2. Determine the direction of water movement, given soil water potentials.

3. Define Darcy's Law and its components and be able to use it in calculations.

4. Describe preferential flow in soils.

5. Describe how preferential flow can affect groundwater quality.

6. Describe how leaching potential differs between nitrate-nitrogen and ammonium-nitrogen in soils of different textures.

7. Explain how plant residues on the soil surface affect surface runoff, evaporation and infiltration.

8. Describe the relationship between saturated hydraulic conductivity and soil pore size distribution.

9. Describe how water infiltration and percolation are affected by:
   a. bulk density.
   b. particle density.
   c. porosity.
   d. structure.
   e. tortuosity.
   f. texture.

10. Relate soil morphological properties with relative rates of water movement through soils.

Competency Area 4. Soil Temperature

1. Describe how soil texture, structure, bulk density and water content affect thermal conductivity and heat capacity.

2. Describe how the following affect soil temperature:
   a. soil colour.
   b. soil water content.
   c. surface residue.
   d. landscape position.
   e. aspect.
   f. land use.

3. Describe soil temperature change at different depths both seasonally and diurnally.

4. Describe factors controlling temperature at different soil depths.

5. Explain how soil temperature affects microbial and chemical processes.

Competency Area 5. Soil Gases

1. Explain how the following affect soil aeration:
   a. bulk density.
   b. porosity.
   c. structure.
   d. organic matter.
   e. water content.

2. Explain how irrigation or precipitation affects soil oxygen content.

3. Identify major potential soil gases.

Competency Area 6. Soil Mechanical Properties

1. Compare the shrink-swell potentials of various soils.

2. Identify soil properties that influence shrink swell potential.

3. Relate soil texture, structure and mineralogy to soil compaction.

4. Describe how soil compaction affects infiltration, permeability, bulk density and thermal conductivity.

5. Define liquid limit, plastic limit, and plasticity index.

SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION

Competency Area 1. Soil Forming Factors

1. Define
   a. soil.
   b. rock.
   c. mineral material.
   d. amorphous material.

2. Describe the five soil forming factors.

3. Describe processes and landscape characteristics that result in the formation of soils.

4. Define the following parent materials:
   a. alluvium.
   b. colluvium.
   c. glacial till.
   d. aeolian sands.
   e. marine sediments.
   f. *in situ* parent material (residuum).
   g. coastal sediments.
   h. lacustrine sediments.
   i. loess.
   j. volcanic ash.
   k. human transported materials.
   l. saprolite.
   m. laterite.
   n. ferricrete.
   o. silcrete.
   p. alcrete.

5. Arrange a set of soil descriptions as they would occur in a toposequence, chronosequence, climosequence, and biosequence.

6. Given soil descriptions, identify the dominant soil forming factor that influenced the development of horizons.

Competency Area 2. Horizon Forming Processes

1. Describe the following terms or processes:
   a. eluviation.
   b. illuviation.
   c. redox potential.
   d. chemical weathering.

e. physical weathering.
f. additions.
g. losses.

2. Identify the soil horizon-forming process when given a master horizon or sub-horizon symbol or name.

Competency Area 3. Soil Descriptions

1. Define hue, value, chroma and the Munsell notation of these.

2. Use a soil description to determine the morphological characteristics and horizon nomenclature.

3. Name the diagnostic horizons and the soil order of a soil when given morphological and lab data.

4. Name the essential morphological and chemical features of Hydrosols.

5. Define and describe redoximorphic features, mottles, gleying, and variegated colours.

6. Explain how the following soil characteristics may vary with depth:
   a. structure.
   b. texture.
   c. colour.
   d. bulk density.
   e. porosity.

Competency Area 4. Soil Interpretations and Land Use Management

1. Identify suitabilities and limitations for a map unit from soil mapping databases for the following uses:
   a. crop yields.
   b. recreation.
   c. urban development.
   d. forestry.
   e. septic systems.
   f. wildlife suitability.
   g. engineering properties.
   h. hydrologic properties.

2. Utilize topographic information to evaluate how a landscape partitions water.

Competency Area 5. Soil Classification Concepts

1. Identify the criteria that differentiate the orders of the *Australian Soil Classification*.

2. Given the taxonomic classification, identify all levels of classification.

3. Know how to use the Australia Soil Classification given relevant descriptions of the soil and landscape.

Competency Area 6. Soil Mapping

1. Define the following terms:
   a. complex.
   b. association.
   c. inclusion.
   d. mapping unit.
   e. pedon.
   f. polypedon.
   g. soil series.
   h. profile.
   i. phase.

2. Recognize information in a modern soil mapping database.

3. Explain the limitations of soil surveys and importance of site specific evaluation.

Competency Area 7. Geomorphology

1. Identify the following landforms:
   a. flood plain.
   b. coastal plain.
   c. playa.
   d. meander scar.
   e. till plain.
   f. lake plain.
   g. alluvial terrace.
   h. outwash plain.
   i. moraine.
   j. alluvial fan.
   k. prior streams.
   l. swale.
   m. dune.
   n. bog, fen, moor.

o. terrace.
p. breakaways.

2. Differentiate the properties of soils formed in the following hillslope positions:
   a. summit.
   b. shoulder.
   c. backslope.
   d. footslope.
   e. toeslope.

Competency Area 8. Soil Forming Environments

1. Identify how morphological, chemical, biological, and physical soil properties vary in the following landscapes:
   a. forest.
   b. desert.
   c. rangelands.
   d. alpine.
   e. wetlands.
   f. agriculture.
   g. urban.
   h. mining.
   i. coastal acid sulphate soils.

SOIL BIOLOGY AND SOIL ECOLOGY

Competency Area 1. Living Soil Constituents

1. Name the major groups of soil microorganisms involved with organic residue decomposition.

2. Rank the relative populations or biomass of the following microorganisms per gram of dry soil:
   a. bacteria.
   b. actinomycetes.
   c. fungi.

3. Describe the importance of soil microorganisms to soil processes.

4. Describe the role of the following fauna and flora in soil.
   a. nematodes.
   b. protozoa.
   c. earthworms.
   d. arthropods.
   e. soil fungi.

5. Define rhizosphere and understand its relationship to soil organisms.

Competency Area 2. Soil Ecology

1. Identify the optimal levels of soil temperature, moisture potential, oxygen and pH for activity of major categories of aerobic microorganisms.

2. Identify how changes in temperature, organic matter level, moisture potential and pH affect soil microbial activity.

3. Explain how soil organic matter, soil nutrient levels and pH influence the overall abundance of soil organisms and their relative proportions.

4. Describe deleterious interactions between plant roots and soil fungi.

5. Explain why earthworms and insects are important to the decomposition of organic residues in soil.

6. Describe the benefits to both the fungi and plant in a mycorrhizal symbiosis.

7. Describe the benefits to both the rhizobia and the legume in the N_2-fixing symbiosis.

8. Explain how microbial biomass and its activity differs under intensive tillage and zero-till.

9. Explain the differences in the relative proportions of the major groups of microorganisms in soils under intensive tillage versus zero-till.

10. Describe the conditions that affect the establishment of mycorrhizal associations.

11. Describe how the following factors affect nodulation of leguminous and actinorhizal plants.
    a. pH.
    b. inorganic N.
    c. aluminium.
    d. temperature.
    e. moisture.
    f. macronutrients.
    g. micronutrients.

Competency Area 3. Biological and Biochemical Activities

1. Know the following cycles:
    a. carbon.
    b. nitrogen.
    c. phosphorus.
    d. sulfur.

2. Define how microbial activities affect reduction and oxidation of the following:
    a. iron.
    b. manganese.
    c. nitrogen.
    d. sulfur.

3. Describe decomposition processes of organic materials added to soil.

4. Describe how the rate of decomposition of organic material varies based on:
    a. C/N ratio.
    b. lignin content.
    c. oxidation state of carbon.

5. Calculate the carbon to nitrogen ratio given the appropriate data.

6. Identify how the following soil factors affect the rate of decomposition of organic materials:
    a. pH.
    b. moisture.
    c. temperature.
    d. aeration.
    e. oxidation-reduction potential.
    f. inorganic nutrients.
    g. soil texture.

7. Describe the fate of carbon in organic matter decomposition.

8. Calculate the amount of plant-available nutrients released from organic amendments based on given mineralization and application rates for:
    a. nitrogen.
    b. phosphorus.

9. Define the following processes for the nitrogen cycle:
    a. nitrification.
    b. denitrification.
    c. biological nitrogen fixation.
    d. immobilization.
    e. mineralization.
    f. ammonification.
    g. volatilization.

10. Identify environmental conditions that determine the rate of the following nitrogen cycle processes:
    a. nitrification.
    b. denitrification.
    c. biological nitrogen fixation.
    d. immobilization.
    e. mineralization.
    f. ammonification.
    g. volatilization.

Competency Area 4. Soil Organic Matter

1. Explain how organic matter affects soil aggregate formation and stability.

2. Identify how organic matter interacts with the following ions and elements in the soil:
    a. nitrate.
    b. phosphate.
    c. calcium.

d. aluminium.
e. iron.
f. pesticides.
g. xenobiotics.
h. hydrocarbons.

3. Describe the chemical and physical characteristics of soil organic matter.

4. Explain the importance of the particulate, humus and recalcitrant soil organic matter fractions.

5. Explain the role that microorganisms play in organic matter cycling.

6. Describe the biological, physical and chemical properties imparted to soil by organic matter.

7. Describe how the following affect the amount of organic matter present in soil:
   a. management.
   b. texture.
   c. precipitation.
   d. temperature.
   e. topography.
   f. vegetation.
   g. aspect.

Competency Area 5. Environmental and Agricultural Applications

1. Define and describe bioremediation.

2. Define and describe phytoremediation.

3. Describe the role of soil microbes in bioremediation.

4. Describe how soil microbes facilitate waste management in the following:
   a. composting.
   b. septic systems.
   c. lagoons.
   d. land application of biosolids.
   e. land application of animal manures.
   f. remediation of hydrocarbon contamination.

5. Explain why bacteria are important to anaerobic decomposition of xenobiotics.

6. Describe the role of bacteria in the production of acidity from reduced sulfur and iron minerals.

7. Describe how microbial activities impact the production and consumption of the following greenhouse gases:
   a. carbon dioxide.
   b. nitrous oxide.
   c. methane.
   d. water vapor.

8. Explain why thermophilic bacteria are important in composting.

9. Explain why fungi are important to the decomposition of forest floor litter.

10. Explain the role of bacteria in wetlands.

11. Explain the importance of soil biota to nitrogen availability from plant residues, manures, and other organic residues.

12. Explain the importance of soil biota to phosphorus availability from plant residues, manures, and other organic residues.

13. Describe factors important to the successful use of rhizobial inoculants with legume crop establishment.

14. Explain how no-tillage promotes fungal activity in soil.

SOIL AND LAND USE MANAGEMENT

Competency Area 1. Erosion and Sediment Control

1. Define each factor of the latest version of the Revised Universal Soil Loss Equation.

2. Explain how conservation practices affect soil loss estimates using the latest version of the Revised Universal Soil Loss Equation.

3. Apply the latest version of the Revised Universal Soil Loss Equation given appropriate data.

4. Describe factors affecting sediment load in water.

5. Identify soil conditions and management practices that contribute to soil erosion by water.

6. Identify soil conditions, structures and management practices that help control soil erosion by water.

7. Identify the following erosion types:
   a. sheet, interill, or splash.
   b. rill.
   c. gully.

8. Describe the important soil factors controlling wind erosion.

9. Identify the conservation practices that affect the severity of soil erosion by wind.

10. Characterize processes associated with wind erosion.

11. Identify soil conditions and management practices that contribute to wind erosion.

12. Identify soil conditions, structures and management practices that help control wind erosion.

13. Explain the effects of wind and/or water erosion on soil properties.

14. Explain the effects of residue management on soil erosion.

15. Describe the erosion potential for:
    a. construction sites.
    b. paved areas.

c. agricultural land.
d. forested land.
e. rangelands/pastures.
f. desert.
g. mining.

16. Define highly erodible land.

Competency Area 2. Wetlands and Hydric Soils

1. Describe the functions and values of wetlands.

2. Describe how constructed wetlands can be used to treat contaminated water.

3. Identify morphologic properties of hydric soil indicators.

Competency Area 3. Soil Quality and Management

1. Define soil quality in a specified context.

2. Describe how land use, physical, chemical and biological properties influence soil quality:

3. Describe soil carbon sequestration.

4. Describe management practices in agriculture that influence soil carbon dynamics.

5. Describe methods to improve plant growth on
   a. highly acidic soils.
   b. highly alkaline soils.
   c. saline and/or sodic soils.
   d. acid sulphate soils.

6. Describe methods to improve plant growth on wet soils.

7. Describe how to improve the structure of compacted soils.

8. Describe how compaction affects availability and uptake of nutrients and water for plants.

9. Discuss the concept of best management practices (BMPs).

10. Identify BMPs to control:
    a. surface and subsurface nutrient movement.
    b. surface and subsurface pesticide movement.
    c. soil erosion.

Competency Area 4. Waste Management

1. Identify the common soil properties and management practices used to prevent waste products from contaminating groundwater.

2. Identify the common soil properties and management practices used to prevent waste products from contaminating surface water.

3. Describe the soil properties and management practices used to reduce mobility of heavy metals in land-applied municipal biosolids, effluents and industrial wastes.

4. List the hazards associated with land application of municipal biosolids and industrial wastes as a soil amendment.

5. Describe how pH affects the mobility of heavy metals.

6. Describe water quality impacts related to irrigation with wastewater.

7. Describe how the following soil factors affect placement of a septic system:
    a. soil texture.
    b. hydraulic conductivity of soil horizons.
    c. depth to a seasonally high water table.
    d. depth to bedrock.
    e. topographic position.
    f. proximity to a water course.
    g. P-retention index (PRI).

8. Describe soil characteristics that limit the use of different septic systems.

Competency Area 5. Cropland and Field Management

1. Explain the concept and application of precision agriculture.

2. Identify soil conditions that inhibit plant growth.

3. Describe how tillage and residue management affects soil physical, chemical, and biological properties.

Competency Area 6. Water Quality and Management

1. Define the following terms:
   a. eutrophication.
   b. hypoxia.
   c. Total Maximum Daily Loads (TMDLs).
   d. turbidity.

2. Distinguish between point and non-point sources of pollution.

3. Be able to identify sources of potential soil contamination.

4. List techniques for remediation of soils contaminated by chemical leaks and spills.

5. Describe soil properties affected by irrigation with poor quality water.

6. Describe the impacts of nitrogen and phosphorus management practices on water quality.

7. Explain the purpose of vegetative buffers and filter strips.

8. Describe how riparian areas, filter strips and vegetated buffers influence nitrogen, phosphorus and sediment movement.

9. Describe water conservation practices used to reduce frequency of irrigation.

10. Describe water conservation practices used to reduce runoff and leaching from irrigation.

11. Define grey water as it is used in Australia.

Competency Area 7. Regulatory and Resource Agencies

1. Identify the Commonwealth and State agencies responsible for compiling soil survey data.

2. Identify the Commonwealth and State agencies responsible for environmental issues related to:
   a. wetlands.
   b. water quality criteria.
   c. oil and gas production.
   d. surface mining.
   e. agriculture and forestry.
   f. soil erosion.

g. urban development.
h. organic agriculture.

Competency Area 8. Urban Soils

1. Describe unique characteristics of urban soils in post-construction environments.

2. Describe factors that influence water movement in urban soils.

Competency Area 9. Forest Soils

1. Understand soil formation under different forest vegetation types.

2. Define the forest floor and characterize how it affects soil chemical, biological and physical properties.

Competency Area 10. Geospatial Interpretation

1. Define Geographic Information System (GIS), Global Positioning System (GPS), and remote sensing.

2. Given a set of maps and aerial photos at different scales, identify benchmark features for a given site.

3. Describe uses of GIS and GPS in land use management.